A SURVEY OF TRUMPETER SWANS AND THEIR HABITAT IN SOUTHERN MACKENZIE DISTRICT, NORTHWEST TERRITORIES: 1986

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ABSTRACT

Trumpeter swans (Cygnus buccinator) were surveyed and captured in the southern Mackenzie District, NWT from 27 July to 2 August 1986. The purpose of this study was to determine the distribution and abundance of swans in this region. Key morphological characteristics were measured on twenty adult swans to confirm that they were trumpeter swans. Captured swans were also banded and collared to determine migration routes and wintering areas. Eighty-three adult swans, including 33 pairs, were observed. Fifty-five cygnets, in 14 broods, were also noted. The majority of swans were concentrated in the Nahanni Butte area and in the vicinity of Camsell Bend.

RÉSUMÉ

Du 27 juillet au 2 août 1986, on a fait la capture et l'étude de cygnes trompettes (Cygnus buccinator) dans la partie sud du district du Mackenzie, dans les Territoires du Nord-Ouest. L'étude visait à établir la distribution et l'abondance des cygnes dans la région. Des caractéristiques morphologiques clés ont été mesurées chez vingt cygnes adultes, confirmant ainsi leur appartenance à l'espèce de cygnes trompettes. Afin d'établir les routes de migration et les zones d'hivernage, on a posé un collier et une bague aux cygnes capturés. Quatre-vingt-trois cygnes, dont 33 couples, ainsi que cinquante-cinq poussins, représentant 14 couvées ont été observés. La majorité des cygnes se trouvaient dans la région de Nahanni Butte et a proximité de Camsell Bend.

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1.0 INTRODUCTION

1.1 Distribution and Abundance

Scattered flocks of breeding trumpeter swans (Cygnus buccinator) occur in Alaska (King and Conant 1981), Yukon (McKelvey et al. 1983), British Columbia and Alberta (Brechtel 1982), Saskatchewan (Nieman and Isbister 1974), and Montana, Idaho, and Wyoming (Palmer 1976). Geographically, these trumpeter swan flocks comprise the Pacific Coast and Rocky Mountain populations as illustrated in Fig. 1 (Anon. 1984).

The Pacific Coast population breeds in interior and south-central Alaska and winters primarily along the coasts of southern Alaska, British Columbia, Washington, and Oregon. Approximately 600-1000 birds winter in the central interior of British Columbia where open water occurs. Some breeding birds from Yukon may also winter in central British Columbia (B. Turner, CWS, pers. comm.).

The Rocky Mountain population is comprised of a non-migratory "Tri-state" (Montana, Idaho, and Wyoming) subpopulation and a migratory "Interior Canada" subpopulation. Both subpopulations, about (1700 birds) winter in the same area - the headwaters of the Snake River in Idaho and the Yellowstone River in Wyoming. The Interior Canada subpopulation includes a flock that nests in the Peace River area of Alberta and British Columbia and another flock that nests in the Toobally Lakes area of southern Yukon. Additional breeding pairs, to the west of the Toobally Lakes, could belong to either the Pacific Coast or the Rocky Mountain populations.

Although the North American population is approximately 11,450 birds (Anon. 1985), it is considered a rare breeding bird in Canada

Figure 1. Distribution of Pacific Coast(PCP) and Rocky Mountain (RMP) populations of trumpeter swans in North America.

(MacKay 1978). Pre-1985 breeding population estimates include: about 50 pairs in southern Yukon, 61 pairs in west central Alberta, several small pioneer flocks (13 pairs) in other parts of Alberta, 10 pairs in northern British Columbia, and one pair in southwestern Saskatchewan. A small population was recently observed in the southwest portion of Northwest Territories (McCormick 1985, McCormick and Shandruk 1986).

1.2 Breeding Habitat

Several factors influence the suitability of an area as breeding habitat.

Ice-free period: As swan cygnets require 100-120 days to fledge (Banko 1960, Hansen et al. 1971), waterbodies must remain open long enough to allow the cygnets to attain flight. Accordingly, 64°N is the theoretical northern limit for breeding trumpeter swans (Hansen et al. 1971).

Nest Sites: Most swans nest in emergent vegetation (Banko 1960, Hansen et al. 1971, Holton 1982). Nests are often surrounded by a "moat" of open water. Most nest sites in the Grande Prairie, Alberta region were located at least 40 m from shore (Holton 1982). Use of nest sites such as abandoned beaver lodges, small islands, and shorelines have been noted by Hansen et al. (1971) and McKelvey et al. (1983). Islands were utilized on waterbodies with timbered shorelines where there was little emergent vegetation.

Foraging Sites: As adult swans generally forage by "tipping up", the food available within approximately 100 cm of the water surface is a critical factor (Holton 1982). Important food sources in the breeding areas of Alaska, Yukon, and Alberta are listed in McCormick (1985).

Disturbance: Human activity near nesting areas may inhibit successful nesting (Rean 1976, Ellison and Cleary 1978), and increase egg loss to predators (MacInnes et al. 1974, Rean 1976), Beer and Ogilvie 1972). Hansen et al. (1971) reported lower survival of cygnets in areas subjected to human disturbance. This was attributed to the movement of cygnets (and adults) from their natal marshes. Repeated human disturbances may inhibit nesting attempts (Page 1976, Shea 1979). As an example, few nest sites in the Grande Prairie area are within 200 m of shorelines where agricultural activity occurs (Holton 1982).

Most of the above factors are interrelated with the prevailing water levels. Not surprisingly, many nests in Yukon are associated with beaver activity which often stabilizes pond water levels (McKelvey et al. 1983).

1.3 Key Habitat Sites

The Canadian Wildlife Service has recently completed a compilation of the key migratory bird terrestrial habitat sites in the Northwest Territories (McCormick et al. 1984). Any site supporting at least one percent of the Canadian population of a migratory bird species or subspecies, for any portion of the year, is considered to be a key habitat site.

Trumpeter swan breeding habitats in Mackenzie District are priority sites for the following reasons:

1) the trumpeter swan is a rare bird in Canada (COSEWIC) (MacKay 1978),

2) the theoretical northern limit of trumpeter swan breeding habitat is 64° N (Hansen et al. 1971). From available information (air photos, topographic maps), there appears to be considerable suitable but scattered habitat in this region,

3) a 1985 survey (McCormick and Shandruk 1986) revealed several previously unknown breeding sites and a significant regional population,

4) there is a disparity of approximately 500 birds between the autumn production estimates and the higher winter counts of the Rocky Mountain population (R. Gale, Idaho Fish and Game Dept., pers. comm.),

5) a survey of swans in the NWT is a top priority under the North American Trumpeter Swan Management Plan (Anon. 1984) and

6) trumpeter swan breeding sites are potential "Key Terrestrial Habitat Sites" - those sites within the NWT which are essential to the welfare of various migratory bird species in Canada (McCormick et al. 1984).

1.4 Objectives

The objectives of this study were:

1) to confirm that the swans observed during 1984 and 1985 surveys were trumpeter swans,

2) to determine the location and extent of actual and potential trumpeter swan habitat in the southern Mackenzie District,

3) to determine the distribution and abundance of trumpeter swans in the southern Mackenzie District, and

4) to collar a number of trumpeter swans to determine their migration route and wintering areas.

2.0 STUDY AREA

The study area includes that portion of the Mackenzie District which lies west of 121°W and south of 63°N (Fig. 2). Nahanni National Park Reserve is situated in the southern portion of the study area. Communities within the study area include: Wrigley, Fort Simpson, Jean Marie River, Fort Liard, Nahanni Butte and Tungsten.

2.1 Physiography

The study area includes both the Cordilleran (Mackenzie Mountain Area) and Interior Plains physiographic regions. The Mackenzie Mountain Area is represented by the Mackenzie Mountains, the Mackenzie Plain, and the Liard Plateau divisions. The Interior Plains include the Great Slave Plain, the Alberta Plateau, and the Fort Nelson Lowland divisions (Bostock 1967).

The Mackenzie Mountains comprise several diverse physiographic elements that impose a pronounced north-south orientation to the country (Douglas and Norris 1960). The peaks and ridges of the interior reach to 2600 m while the more easterly ranges are lower and divided by wide valleys or cut by deep canyons. The timberline is low and the mountains present an aspect of bare, rock-covered slopes with few cliffs (Bostock 1970).

The Mackenzie Plain is a broad (50-90 km), rolling drift and tree-covered plain lying between the Mackenzie and Franklin mountains.

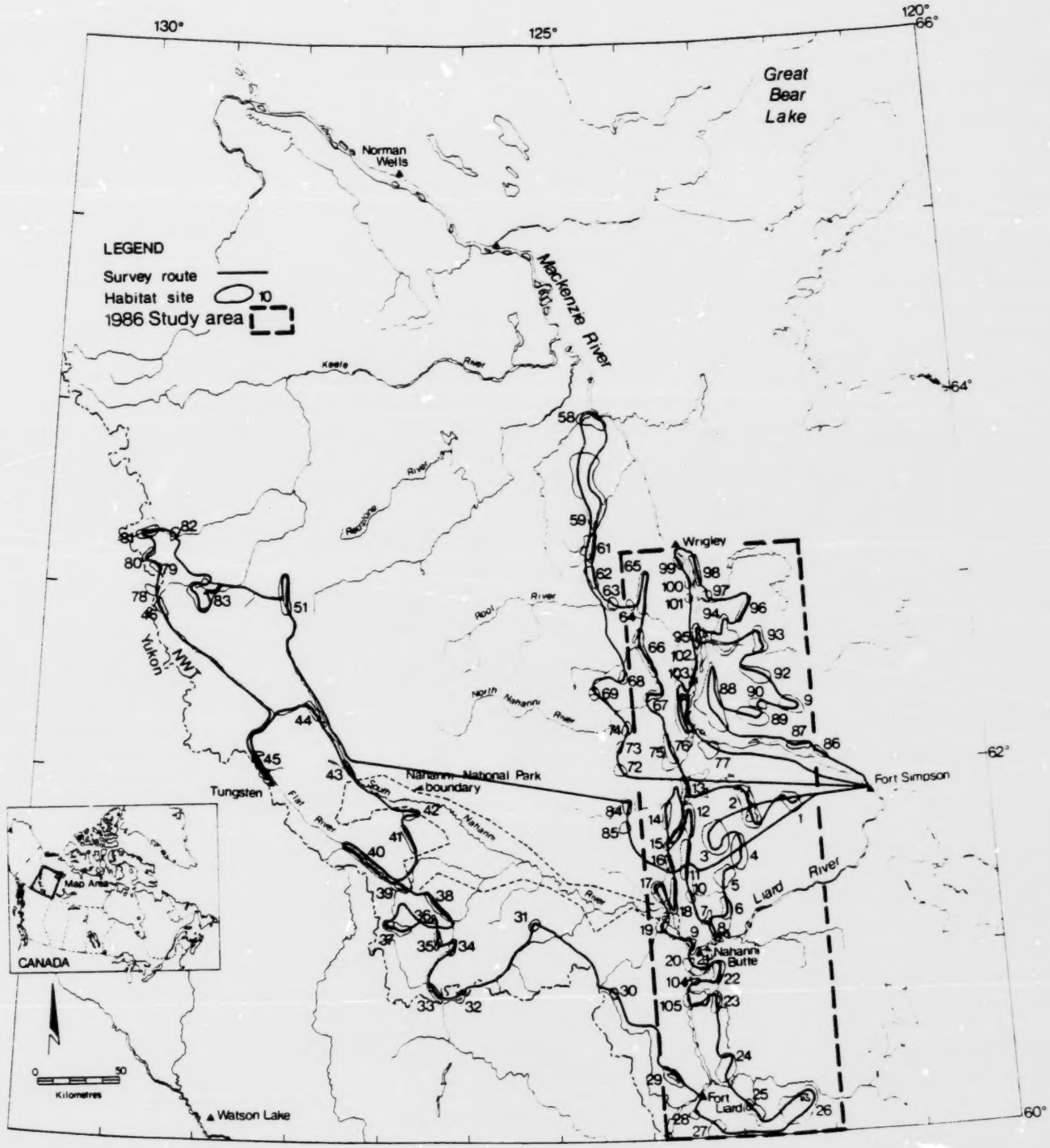

Figure 2. Location of the study area within Northwest Territories.

The plain is an area of mainly low elevation and relief through which the Mackenzie River flows for much of its course.

The Liard Plateau, between the South Nahanni and Liard rivers, is a region of tree and tundra-covered hills. Most of the summits which are less than 1375 m in elevation are flat, but extensive remnants of former erosion surfaces are evident. The valleys are narrow and deeply incised.

The Great Slave Plain lies east of the Franklin Mountains and north of approximately 61° N. The low-lying, almost-flat terrain is covered by muskeg and numerous small, shallow lakes. Most of the region lies below 300 m elevation, however, three flat upland areas occur north of the Liard River. The highest, known as Martin Hills, attains an elevation of approximately 690 m elevation.

The Alberta Plateau, in the southeast, is composed of Cretaceous sediments and consists of a ring of plateaus (Cameron Hills and Caribou Mountains) separated by wide valleys. These hills form a disconnected escarpment with summits between 770 and 985 m elevation overlooking Great Slave Plain. Flat topped hills are the main feature of the topography.

The Fort Nelson Lowland lies south of the Alberta Plateau and east of the Liard Plateau. The rivers and their main tributaries are entrenched into the valleys which rise from less than 300 m in the north and northeast to about 770 m elevation in the west.

2.2 Geology

The Cordilleran region is largely composed of sedimentary rocks; particularly shales, siltstones, sandstones, limestones, and dolomites

(Gabrielse et al. 1973). Most of the surficial materials were derived locally from the weathering of bedrock and were transported relatively short distances by glaciers, gravity or running water. Fast-flowing creeks, prone to flash floods, have deposited gravel and rock rubble along their channels whereas well-sorted sand and gravel occur in the beds of rivers and larger creeks. Fine-grained sand mixed with organic debris occur on the floodplains of the larger rivers, along with locally-occurring gravel bars. Sites of ancient glacial lakes also occur in some river valleys (Gabrielse et al. 1973).

The Interior Plains region is generally covered by a mantle of glacial till occurring as ground moraine with low rolling relief. Exposures of bedrock are relatively rare, except along some of the large rivers. Silt-clay plains, originating from glacial lake deposits, border many of the larger rivers. These areas are commonly covered by a mantle of sand and silty sand. Riverine deposits include silt, sand, peat, and gravel which occur in river channels, floodplains, and low terraces adjoining the rivers and alluvial fans. Organic terrain occurs in wet areas where there is no organized drainage and water remains on the ground surface throughout the summer months.

2.3 Climate

The area experiences a continental climate with short warm summers and long cold winters. The growing season is short and never free from the danger of frost. Climatic data are not available for much of the study area, however, certain inferences may be drawn from existing meteorological stations (Table 1).

Table 1. Climatic data from stations in southern Mackenzie District, NWT (1951-1980)[1].

Community	Elev. (m)	May		June		July		August		September		Frost-Free Period (Days)
		T[2]	R[3]	T	R	T	R	T	R	T	R	
Wrigley	156	7.3	21.8	14.0	43.4	16.0	54.3	13.8	46.0	6.6	27.2	70
Tungsten	1143	2.1	19.2	9.0	68.4	10.9	90.9	9.5	72.3	3.3	55.7	42
Fort Simpson	169	7.9	20.4	14.4	32.0	16.6	51.2	14.4	36.9	7.3	23.1	79
Fort Liard	213	8.7	33.0	14.3	55.1	16.7	109.8	15.0	55.3	9.2	49.9	115

1 From: Atms. Env. Serv. (1982 a, b, c.)

2 Mean Temperature (0°C).

3 Mean Rainfall (mm).

Although summer temperatures and the frost-free period decrease significantly with increasing latitude, and particularly with increasing altitude, the pattern of rainfall is somewhat different. Tungsten receives the greatest rainfall of any station. Fort Simpson, however, receives less rainfall than other communities, perhaps because of its distance from the mountains.

Only general observations about climate can be made in light of the limited number of meteorological stations. Also, the diverse and complex topography of the area results in localized climates which may vary markedly from general regional patterns.

2.4 Vegetation

The montane vegetation is characterized by an altitudinal transition from the relatively dense forests of the lowlands to the alpine tundra on the mountains (Scotter et al. 1971). In the Flat-South Nahanni rivers area, the treeline occurs at approximately 1200 m on south and west-facing slopes and at 1100 m on the north and east-facing slopes. The treeline is lower at higher latitudes. In valley bottoms, especially on floodplains, white spruce (Picea glauca) and balsam poplar (Populus balsamifera) occur and the shrub layer consists of alder (Alnus incana), low-bush cranberry (Viburnum edule) and wild rose (Rosa acicularis).

At higher altitudes and on north-facing slopes, black spruce (Picea mariana) becomes prominent and occurs with white spruce, lodgepole pine (Pinus contorta) or jackpine (P. banksiana). Alder (Alnus spp.) and labrador tea (Ledum groenlandicum) comprise the shrub layer. At higher levels the forest grades into open black spruce and

reindeer lichens and finally into alpine tundra characterized by mountain avens (Dryas spp.), ericaceous shrubs, sedges and grasses.

The Interior Plains vegetation is characterized as follows (Anon. 1974): Recent alluvial soils of the Interior Plains support forests of white spruce, balsam, poplar and aspen in mixed or pure stands (Anon. 1974). The shrub layer consists of alder, willow (Salix spp.), roses, and Viburnum spp. Older alluvial soils are characterized by black and white spruce in pure or mixed stands. White birch (Betula papyrifera) and poplar may form a minor component. Labrador tea and Vaccinium spp. comprise the shrub layer and sphagnum and feather mosses make up the ground cover.

Moderately drained glacial tills or lacustrine deposits of the Interior Plains support white spruce in pure stands or in association with black spruce, aspen (P. tremuloides), balsam poplar, and white birch. Willow, alder, dwarf birch (B. nana and B. glandulosa), and Rosa acicularis are present in varying amounts. Equisetum sp. and Pyrola sp. are the most common herbaceous species. Well-drained upland sites support jack pine in pure stands or in association with aspen, white birch, and spruce. Sparse to moderate growth of Rosa acicularis, Linnaea borealis and various species of Vaccinium are common. Mosses are usually absent in pure hardwood stands but increase as the coniferous component of the forest increases. Upland sites which support black spruce and sphagnum or lichen represent the transition from forest to tundra. Larch (Larix laricine) may also occur in limited amounts. Dwarf birch, alder and willow form the sparse upper shrub layer, whereas Labrador tea (Vaccinium spp.), Potentilla fruticosa, Rubus chamaemorus

and roses comprise the low shrub layer. Sphagnum, feather mosses and lichens cover the ground.

3.0 METHODS

Potential swan breeding sites were identified on the basis of past observations (McCormick 1985, McCormick and Shandruk 1986), discussions with individuals who are familiar with the region, and physical features (see Section 1.2) which could be interpreted from topographic maps, air photos, and available literature. The sites were highlighted on 1:250,000 topographic maps and an appropriate survey route was determined. The survey was carried out when the cygnets were half-grown. This provided an indication of production. Most cygnets at this date would likely survive to fall migration.

The survey was flown from 27-31 July, 1986 in a Cessna 185 at approximately 150 m agl and at about 225 km/h. Two observers accompanied the pilot. All waterbodies within sight of the survey route were examined. Upon sighting one or more swans, flight altitude and speed were reduced to determine: 1) number of adults present, 2) breeding status of the birds, and 3) number of cygnets present. Habitat information was also recorded. Habitat quality was subjectively rated on the basis of physical and vegetative features of the wetlands (Appendix 2). Observations were also recorded on: wetland type, submergent vegetation, emergent vegetation, width of emergent vegetation and water turbidity. Photographs were taken of many of the wetlands to aid in their evaluation and for future reference.

Moulting swans were captured, from 1-2 August,1986, by "herding" them into emergent vegetation with a helicopter and picking them up with a large dip net. Captured birds were fitted with plastic collars (white alpha-numeric code on a red base - Appendix 3) and stainless steel leg bands. They were also weighed and measured (Appendix 4) before being released in the waterbody where they were captured. Fecal samples were also collected, when possible, for diet analysis.

4.0 RESULTS AND DISCUSSION

A total of 84 adults and 55 cygnets were observed (Table 2). The total adults included 33 pairs, two groups of three birds, and 11 lone birds. The 14 broods averaged 3.9 (range 1-7) cygnets each. The majority of birds were concentrated in the Nahanni Butte-Camsell Bend area. The remaining swans were scattered throughout montane areas and in the vicinity of Fort Liard.

4.1 Swan Habitats

Trumpeter swans were observed in the following locations:

Area 9: This area consists of several ponds in an extensive sedge meadow interspersed with alder (Alnus sp.) shrubs. The emergent vegetation consisted of cattail (Typha latifolia) bordered by an inner band of bog-rush (Juncus sp.) which graded into a zone of horsetail (Equisetum sp.). Horsetail covered extensive areas of the ponds. Waterlily (Nuphar variegatum) was the only obvious submergent species.

A pair, with no young, was observed at this site. In 1985, a pair was attending four eggs on 28 May and one young was present on

Table 2. Observations of trumpeter swans in southern Mackenzie District, July 1986.

Site No.	Wetland Type*	Map No.	UTM Location	Habitat Rating**	Swans Observed A	B	C	=D***
9	3,6	95G	DC 692 755	good	1			2
11	2,6	95G	DD 715 742	good			1	1
13	1,2,3,4	95G	DD 715 555	good	1			2
14	2,6	95G	DD 645 510	good			1	1
14	2,6	95G	DD 642 500	good			1	1
14	2,6	95G	DD 642 492	good	1	5		7
14	2,6	95G	DD 630 425	good	1	5		7
15	1,2	95G	DD 685 372	good	1			2
15	1,2	95G	DD 665 355	good	1	5		7
15	1,2	95G	DD 627 262	good	1			2
15	1,2	95G	DD 627 260	good	1			2
16	1,2	95G	DD 627 240	good			1	1
16	1,2	95G	DD 627 240	good	1			2
18	2,6	95G	DD 660 040	good	1	4		6
18	2,6	95G	DD 637 000	good	1	2		4
18	2,6	95G	DC 622 940	good	1			2
19	1,2,5	95G	DC 582 860	good	1	5		7
19	1,2,5	95G	DC 577 837	good	1			2
19	1,2,5	95G	DC 577 837	good			1	1
20	1,6	95B	DC 720 615	good			1	1
20	1,6	95B	DC 660 580	good	1	2		4
21	2,3	95B	DC 805 537	good	1	4		6
22	2,3	95B	DC 875 515	good	1	7		9
22	2,3	95B	DC 872 470	good	1			2
22	2,3	95B	DC 847 472	good	1			2
25	1,5	95B	EB 080 675	fair	1			2
25	1,5	95B	EB 112 640	fair			1	1
26	1,5	95B	EB 357 670	poor			3	3
29	1,2,3	95B	DB 550 920	good	1			2
33	2,6	95D	XT 457 407	fair			1	1
35	1,6	95E	XT 435 750	poor	1			2
41	2,3,6	95E	XU 260 317	good			1	1
42	1	95E	XU 220 545	good	1			2
43	1,5	95L	WU 852 825	good			1	1
44	3	95L	WV 620 165	fair	1	4		6
65	2,6	95O	DE 545 815	good			1	1
66	2,3,6	95O	DE 605 362	good	1			2
67	1,3,6	95O	DE 612 217	good	1	4		6
67	1,3,6	95O	DE 547 215	good	1			2
75	1,6	95K	DD 690 912	good			1	1
75	1,6	95K	DD 707 820	good			3	3

Table 2. Continued.

Site No.	Wetland Type*	Map No.	UTM Location	Habitat Rating**	Swans Observed A	B	C	=D***
76	1,6	95J	DE 747 160	fair	1	2		4
76	1,6	95J	DE 732 052	fair	1			2
103	1	95J	DE 810 267	poor	1	1		3
104	1	95B	DC 760 487	poor	1			2
105	1,6	95B	DC 702 390	good	1	5		7

* 1=lake, 2=creek, 3=oxbow lake, 4=river, 5=pond, 6=pond complex
**see Appendix 2
***A=pairs, B=cygnets, C=singles and groups, D=total birds observed

10 September (Heap 1985). A pair, attending six eggs, was also observed here in June, 1984 (McCormick 1985). It is suspected that this was a breeding pair whose eggs or young were predated.

Site 11: The wetlands at this site consist of a creek and a complex of ponds. Both emergent and submergent vegetation was abundant and diverse.

One adult was seen at this site. Although no birds were seen in early August 1985 (McCormick and Shandruk 1986), a pair was observed in early June 1985 (Heap 1985).

Site 13: A pair was observed on a large pond at this site. There are no previous records from this site. The pond had an abundant growth of waterlily.

Site 14: This area includes a creek, small oxbow lakes, and ponds. Emergent vegetation included sedge (Carex sp.) and horsetail (Equisetum sp.) which was greater than 40 m wide in several locations.

This was a very productive site. Two single birds and two pairs, each with five cygnets, were observed. Only one pair, with no cygnets, was observed at this site in 1985 (McCormick and Shandruk 1986). However, the number of swans present in 1985 may have been underestimated due to the high and thick emergent vegetation (unpubl. data). This factor also applies to some of the subsequent areas.

Site 15: This site consists of a meandering creek with associated ponds and wetlands. The waterbodies are surrounded by dense conifers and have well developed emergent zones along much of their perimeters.

Three pairs and a pair with five cygnets were observed at this

site. Such observations were rather surprising as no birds were seen, at this site, during previous surveys. However, the above-mentioned factor also applies to this site.

Site 16: This site includes two lakes and a meandering stream with its adjacent ponds and wetlands. All waterbodies had well developed emergent vegetation.

Two pairs and a single bird were observed in this site despite no previous records.

Site 18: The site includes a creek, ponds, and pond complexes. Reedgrass (Calamagrostis spp.), sedge and horsetail were common but usually less than 40 m wide. Numerous standing dead trees suggested that the area had been flooded, possibly by beavers.

A nonbreeding pair, a pair with two cygnets and a pair with four cygnets were observed at this site. Two nonbreeding pairs and a pair with five cygnets were observed at this site in 1985 (McCormick and Shandruk 1986). The only previous observation was six moulting birds which were seen at this site in 1980 (Anon 1980).

Site 19: This site includes Yohin Lake, Jackfish River, and associated wetlands. Yohin Lake is shallow with a mosaic of open water, sedge islands, and extensive stands of emergent aquatics such as waterlily and horsetail. Bogrush and cattails predominate along the margins of the lake and larger islands. Northern arms of the lake consist of sinkholes with minimal marginal vegetation. Other wetlands also have developed emergent and submergent vegetation.

A pair with five young was observed on Yohin Lake whereas a nonbreeding pair and a single bird were seen on ponds adjacent to Jackfish River. A pair with three young was seen on Yohin Lake in 1985 (McCormick and Shandruk 1986) whereas a nonbreeding pair and a pair with five cygnets was observed here in 1984 (McCormick 1985). Breeding was first recorded on Yohin Lake in 1977.

Site 20: This site is an extensive complex of ponds with shallow water. Reedgrass, sedge, horsetail and water lily are common. The width of the emergent zone was usually greater than 40 m.

A pair with four young and a single adult were seen at this site. A group of four adults and a pair with four cygnets were observed in 1985 (McCormick and Shandruk 1986).

Area 21: Several ponds and oxbow lakes occupy an abandoned river channel at this site. Extensive stands of horsetail were apparent on most of the ponds.

A pair with four cygnets was observed at this site. In 1985, a pair with three young was observed (McCormick and Shandruk 1986).

Site 22: This site includes the Netla River and four small lakes which occupy abandoned river channels. Broad stands of sedge and horsetail are common.

A pair with seven cygnets and two nonbreeding pairs were observed at this site. A nonbreeding pair and a pair with four cygnets were recorded at this site in 1985 (McCormick and Shandruk 1986). Probably the same pair was observed on the Netla River, with six young, in early July, 1985. Three adult birds were also observed near the Netla River on the same date (Heap 1985).

Site 25: This site includes Lake Bovie and a number of surrounding lakes and ponds. Reed grass, sedge, and horsetail were present but in limited quantities.

A nonbreeding pair and a single adult were observed at this site. A lone bird was observed in 1985 (McCormick and Shandruk 1986) and a single adult was seen on Lake Bovie in 1977 (Quinlan 1978).

Site 26: This site includes Celibeta Lake and several smaller associated lakes and ponds. Sedge is common in some areas; water lilies and pondweeds (Potamogeton spp.) are present. It was considered to be poor habitat (McCormick and Shandruk 1986).

A group of three adults was observed here is the first recorded observation at this site.

Site 29: Fisherman Lake and adjacent wetlands are included in this site. The western end of the lake is characterized by diverse emergent and submergent vegetation.

A nonbreeding pair was observed at this site which is the first record for Fisherman Lake.

Site 33: This site includes a creek and adjacent pond complexes. Reedgrass, sedge and submergent vegetation were present. The site is above 760 m elevation and much higher than most swan breeding sites in this area.

The lone adult which was observed here, is the first record for this site.

Site 35: This site includes a group of small lakes and associated wetlands. Limited margins of reedgrass and sedge were apparent, in addition to submergent vegetation. The site was considered to be poor swan habitat.

A nonbreeding pair was observed at this site. A group of three birds and a lone bird were observed here in 1985 (McCormick and Shandruk 1986).

Site 41: Irvine Creek is a slow-flowing, meandering stream with numerous oxbow lakes and adjacent ponds. Well developed margins of sedge occur on some of the larger waterbodies. The site is above 610 m elevation.

A single bird was observed at this site. No birds were observed in August, 1985 (McCormick and Shandruk 1986) however, one bird was seen in May, 1985 and a pair was observed in September, 1985 (Heap 1985). A pair of swans was also observed at this site in 1984 (McCormick 1985).

Site 42: This site includes two lakes which appear to be deep with narrow sedge margins. Pondweeds and water lilies are abundant in areas. The western lake is above 610 m elevation while the eastern lake is at least 150 m higher.

A nonbreeding pair was seen on the western lake. In 1985, four birds were noted on the western lake in late May whereas a pair was seen on the eastern lake in late July. A pair was also noted on the eastern lake in mid August (Heap 1985). A pair was defending a nest of six eggs, on the western lake, in June, 1984 (McCormick 1985).

Site 43: Many of the ponds at this site are sinkholes with limited emergent vegetation but a few have well developed margins of diverse emergent vegetation. The habitat ranges from poor to good, depending on the amount and diversity of emergent and submergent vegetation.

A single bird was observed at this site, as in 1985 (McCormick and Shandruk 1986).

Site 44: A pair with three cygnets was observed in this area which consists of a complex of ponds on the South Nahanni River flood-plain. Extensive stands of reedgrass, sedge and horsetail were present. This is the first breeding record for this area although the birds have been known to local residents for some time (J. Jensen, pers. comm.).

Site 46: A pair of swans were recorded in this area which includes a lake and several ponds. Extensive stands of sedge were present. There are no previous records for this area of fair swan habitat.

Site 65: This site includes the upper reaches of Wrigley River and its adjacent wetlands. Extensive, diverse margins of emergent vegetation were present on many of the wetlands.

A single adult was observed at this site although a pair was seen here in 1985 (McCormick and Shandruk 1986).

Site 66: This site includes Carlson Creek, its associated wetlands and a number of adjacent small lakes. Good margins of reed grass and sedge are present on many of the waterbodies.

A nonbreeding pair was observed at this site. A pair and a group of four adults were observed here in 1985 (McCormick and Shandruk 1986).

Site 67: This site includes Carlson Lake and the upper reaches of its outlet, Carlson Creek. Sedge and horsetail were common in some portions of the lake and along some of the adjacent wetlands.

A nonbreeding pair and a pair with four young were observed on Carlson Lake. A pair of swans was seen at this site in 1985 (McCormick and Shandruk 1986). In 1985, it was hypothesized that the concentration of birds in sites 66 and 67 represented a focus of breeding. The 1986 observations confirmed this interpretation.

Site 74: A lone bird was recorded on the unnamed lake at this site. Although the lake had limited sedge margins, the site was rated as good swan habitat. This is the first record for this site.

Site 75: This site includes an unnamed creek with its adjacent ponds and wetlands. Reedgrass, sedge, and horsetail were common emergent species along with water lilies and pondweeds.

A group of three adults and a single bird were observed at this site. In 1985, two lone birds were seen on separate ponds at this site (McCormick and Shandruk 1986).

Site 76: This site is an extensive network of lakes, ponds and pond complexes which occurs adjacent to the MacKenzie River, between the Root and Ram rivers. Reedgrass and sedge are common emergent species.

A pair with two cygnets and a nonbreeding pair were observed at this site. A nonbreeding pair of swans was seen at this site in 1985 (McCormick and Shandruk 1986).

Site 103: This site includes a number of small lakes just north of the Root River - MacKenzie River junction. Sedge and water lilies were present in the lakes but the area generally seemed to be poor swan habitat.

A pair with one cygnet was observed at this site. Although this is the first observation at this site, it was not previously surveyed.

Breeding may have occurred here in previous years.

Site 104: This site is an abandoned river channel between two portions of the Liard River. Trees occur virtually to the edge of the channel. Sedge is present in some areas.

A nonbreeding pair of swans was seen at this site. Although this is the first record, this site was not surveyed previously.

Site 105: This site includes a small lake and an associated complex of ponds. Reedgrass, sedge and horsetail are common along with water lilies and pondweeds.

A pair with five cygnets was observed at this site, which had not been previously surveyed.

4.2 Swan Distribution

With few exceptions, trumpeter swans were associated with wetlands which occurred on floodplains adjacent to rivers, creeks or lakes (Fig. 3). Prevailing surficial materials in these areas include sand, silt, peat and organic silt (Anon. 1974). Such materials are conducive to the growth of emergent vegetation. The majority of the swans were observed below 300 m agl, but individuals were also observed at approximately 600 m agl (sites 43 and 44) and about 900 m agl (sites 35).

The concentration of birds in the Nahanni Butte-Camsell Bend area is striking (Fig. 3). Sixty-eight adults (including 29 pairs) and 13 broods (51 cygnets) occurred in this area. Only one brood was observed elsewhere (site 44). As suspected during the 1985 survey, breeding swans were observed in the Carlson Lake area.

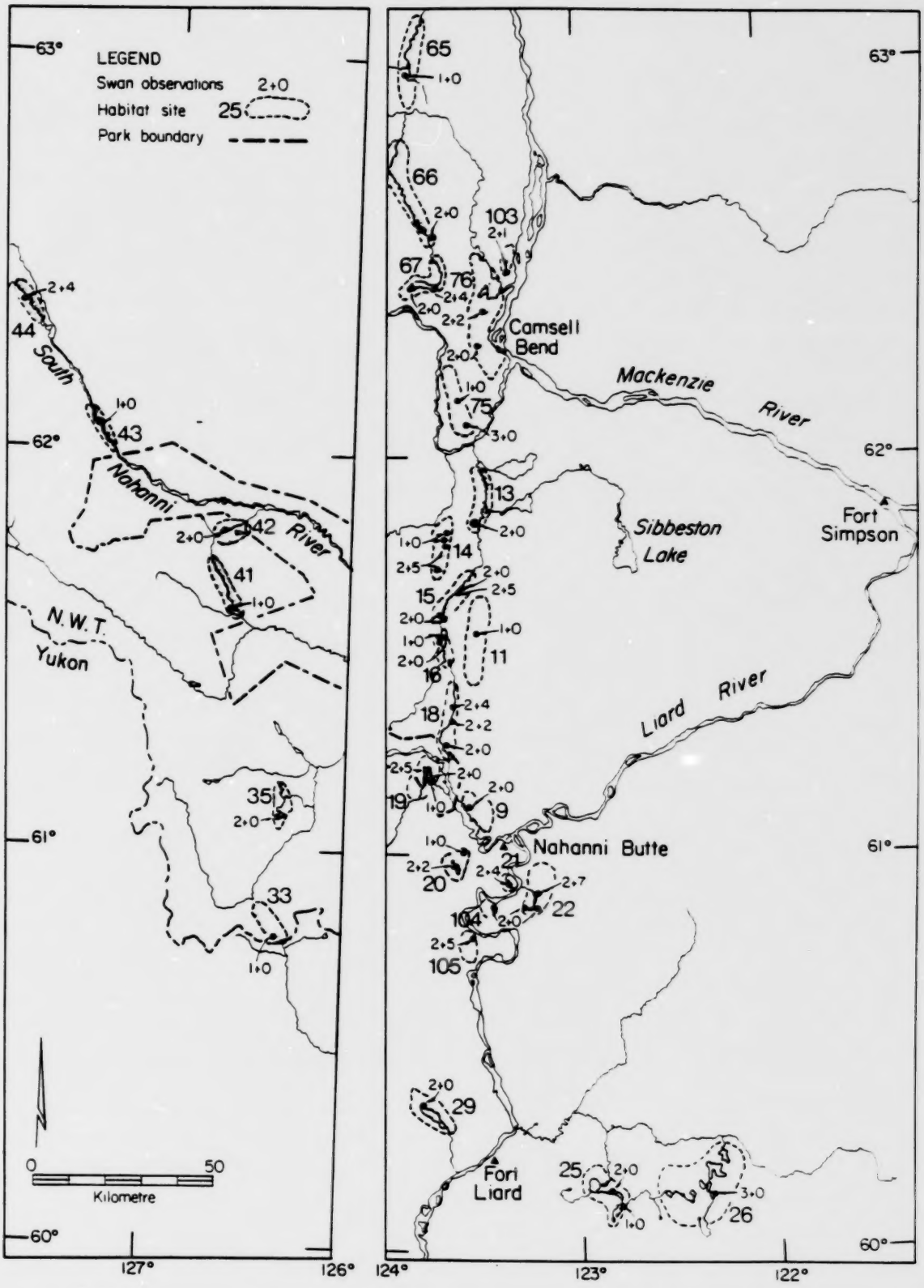

Figure 3. Distribution of trumpeter swans in southern Mackenzie District, July 1986.

A significant increase in swans was also observed in the vicinity of Fort Liard. Whereas one individual was observed in 1985 (McCormick and Shandruk 1986), eight birds including two pairs were recorded during this survey. The two pairs were observed at sites (25 and 29) which were surveyed last year. The group of three birds was observed at a site which had not been previously surveyed.

The distribution of birds in montane areas was similar to that of last year. A pair was again observed at site 42 but there was no evidence of breeding as there had been in 1984 (McCormick 1985).

No birds were seen at the Moose Ponds (site 46) although a pair was observed there earlier in the summer (D. Kirkhus pers. comm.). Similarly, no birds were observed at O'Grady Lake (site 83) despite previous observations at this site.

A significant area of potential habitat was surveyed between Fort Simpson and Wrigley, east of the Mackenzie River. Despite the apparent quality of the habitat (Appendix 2), no swans were observed. However, The occupation of adjacent habitats suggests that this area will soon be exploited if swan numbers continue to increase.

4.3 Estimated Population

The majority of potential breeding areas (Fig. 2) in the southern Mackenzie District was examined during this survey. However, additional observations (Appendix 1) suggest that some swans were not recorded. Appendix 1 includes observations within Nahanni National Park Reserve which we did not survey.

The 1985 survey revealed a total of 51 adults and 24 cygnets

(7 broods) whereas, this survey yielded 84 adults and 55 cygnets (14 broods). Although some of the increase may be attributed to an expanded survey (sites 103-105) it is evident that much of the apparent increase was recorded in sites previously surveyed particularly the Fishtrap Creek-Tetcela River area. It appears that previous numbers may have been underestimated due to our survey technique. Helicopters are clearly superior to fixed-wing aircraft, particularly when the emergent vegetation is quite high (unpubl. data).

In deference to Environment Canada - Parks wishes, we did not survey the portion of the South Nahanni River valley which lies within Nahanni National Park Reserve. A pair and a lone bird were observed in the area in 1984 (McCormick 1985). It seems reasonable to assume that six birds were present during this year (Peterson 1986).

Although 84 adult swans were recorded during this survey, it appears that additional birds were present in the region. The presence of nonbreeding birds near Lake Bovie, Celibeta Lake and in northern British Columbia suggests that swans may be utilizing areas to the east of the Liard Valley. Breeding swans (species undetermined) were observed at Calais Lake (NU 125 210) during summer 1986 (T. Chowns, Dept. Ren. Res., pers. comm.). Clearly, the area east of the Liard Valley and south of the Mackenzie River deserves further scrutiny.

In light of the above observations and the amount of apparently suitable habitat which may not have been surveyed, an estimated minimum of 120 adult trumpeter swans were present in the southern Mackenzie District in summer 1986.

This estimate must be considered in light of the above assumptions. It will be further refined as additional field work is completed. The fall, 1986 Canadian population (Interior Canada subpopulation) consists of about 800 birds. Therefore, the NWT population represents approximately 15% of the total Canadian population.

4.4 Collared Swans

Twenty adults were collared and banded in an attempt to document the migration route and wintering habitat utilized by this flock of trumpeter swans. The majority of birds were marked along the Tetcela River basin and in the vicinity of the confluence of the Netla and Liard rivers (Appendix 3). Eight adult pairs were collared, of which five had cygnets. Only the females of two pairs (one with cygnets and one without) were captured and collared. In addition, a yearling female and a single male were collared.

To facilitate field observations of collared swans, a poster and letter informing observers to watch for red collared swans was developed and distributed throughout the suspected migration wintering areas.

Observations, obtained to January, 1987 are summarized in Table 3. From these limited observations, it seems that the NWT flock probably follows the east slope of the Rocky Mountains where it joins with trumpeters from N.E. British Columbia and the Grande Prairie region. Some of the NWT swans likely stage and remain on the large Grande Prairie marshes until they freeze over. Migration from the

Table 3. Observations of trumpeter swans collared in southern Mackenzie District, NWT; October 1986 October 1986 to January 1987.

Collar Code	Date	Location	Status	Cygnets	Observer
Redaa	Sept. 17/86	Fort Nelson, B.C. area	paired	2	Rod McCartney
14aa	Oct. 19/86	Cutbank Slough Grande Prairie, Alta.	Paired in large flocks of swans	?	Brian Anderson
15aa	Oct. 19/86	Cutbank Slough Grande Prairie, Alta.	Paired in large flocks of swans	?	Brian Anderson
Redaa	Nov. 15/86	Goose Lake Lakeview, Oregon	flocked in in flight	-	Joseph Welch
18aa	Nov. 5/86	Yellowstone River, Y.N.P. Wyoming	paired	-	Ruth Gale
11aa	Nov. 5/86	Yellowstone River, Y.N.P. Wyoming	paired	-	Ruth Gale
21aa	Nov. 19/86	Teton River, Idaho	paired	4	Ruth Gale
Redaa	Nov. 19/86	Teton River, Idaho	flocked 3 collars in 276 swans	-	Ruth Gale
14aa	Nov. 20/86	Golden Lake Harriman State Park Idaho	paired	4	Ruth Gale

Table 3. Continued.

Collar	Date	Location	Status	Cygnets	Observer
15aa	Nov. 20/86	Golden Lake Harriman State Park Idaho	paired	4	Ruth Gale
27aa	Nov. 27/86	Round Lake Courer d'Alene, Idaho	single	1	Dr. Wm. Latshaw
Redaa	Dec. 1/86	S.W. Yellowstone Lake, Y.N.P. Wyoming	flocked 7 adults	5	Dave Lockman
24aa	Dec. 29/86	Foster Slough Driggs, Idaho	flocked 30 adults	7	Dave Lockman
21aa	Dec. 29/86	0.8 km S. of Teton Lodge Driggs, Idaho	paired	4	Dave Lockman
25aa	Dec. 29/86	0.8 km S. of Teton Lodge Driggs, Idaho	paired	4	Dave Lockman
30aa	Jan. 23/87	Key Pittman Wildlife Area, Alamo, Nevada	paired	-	Terry Redderer
23aa	Jan. 23/87	Key Pittman Wildlife Area, Alamo, Nevada	found dead	-	Terry Redderer

Grande Prairie region during freeze-up is rapid and direct to the northwestern USA. A large portion of the NWT flock undoubtedly ends up in the Tri-state area along with the majority of the other Canadian breeders.

Although the NWT trumpeter swans migrate to the Tri-state area, there is some evidence that they have also selected and pioneered new wintering habitat in this area. Biologists in the Tri-state area (R. Gale pers. comm.) have observed an increase in the number of trumpeters using the Teton River in Idaho for wintering habitat since about 1980. They have also observed a much higher number of cygnets as compared to adults in this area. These observations coupled with ours on much larger brood size ($x = 3.8 - 4.0$) for northern Canadian breeding trumpeter swans and the fact that the NWT flock was beginning to increase in numbers in the early 1980s, suggest that the NWT swans may be pioneering new wintering habitat on the Teton River. The four other winter observations in Idaho, Oregon and Nevada (Table 3) also support the idea that NWT trumpeter swans may be pioneering new wintering areas. These observations could have far-reaching management implications for Canadian breeding trumpeter swans, once thought to be limited by the amount of wintering habitat in the Tri-state area. Before further transplants or population re-introductions are undertaken, more collaring and observations of the NWT flock would be useful.

Observations were also made on the timing of the moult in adult trumpeter swans. Only two of the 12 pairs which we attempted to capture were capable of flight. Neither of these pairs had cygnets with them.

Only the females of two other pairs were captured. One of these pairs was accompanied by cygnets while the other pair did not have cygnets. Among 8 pairs where both adults were flightless, five had cygnets. Thus, 16 of the 20 captured swans were paired birds indicating considerable overlap of the moult for both sexes. These observations are contrary to those of Hansen et al. (1971) in Alaska where they rarely observed both members of a breeding pair flightless at the same time. Hansen et al (1971). suggested that the moult of females could be tied physiologically to the egg-laying and incubation cycle. Male swans moulted before or after the hatching period on the Copper River and preceeded the female in the Kenai, Alaska. In the Kenai, the males usually started moulting early in the incubation cycle. With an average flightless period of 30 days (Hansen et al. 1971), the males would regain flight soon after the cygnets hatched. This was obviously not the case for the ten males which we captured. However our measurements of ninth primary feather length (males = 265.22 mm $\pm$ 39.17, females = 225.58 mm $\pm$ 31.99) show that males were in a more advanced stage of moult than the females. The more synchronous moult exhibited by the NWT trumpeter swans allowed us to successfully capture and collar adult pairs in a very short period of time.

4.5 Swan Morphometrics

To confirm that the breeding swans of the southern Mackenzie District are trumpeter swans we took selected body measurements while banding and collaring the birds (Appendix 4). These observations are summarized and presented in Table 4. Appropriate measurements for determining species of swans are; culmen length, tarsus length, distance

Table 4. Mean body measurements of adult trumpeter swans, southern Mackenzie District, NWT, August 1986.

	Males (n=10)	Females (n=10)
Culmen	114.88 mm ± 3.70	115.23 mm ± 3.19
Tarsus	128.83 mm ± 6.16	121.57 mm ± 3.03
Bill to Nares	54.39 mm ± 2.57	52.08 mm ± 1.48
Weight	12.06 kg ± 1.09	10.23 kg ± 0.52

from bill tip to the anterior of the nares and weight (Banko 1960). All measurements for trumpeter swans, except for the tarsus length of females, exceeded those presented by Banko (1960). Scott (1972) presented mean weights for adult trumpeter swan males (11.9 kg) and females (9.4 kg) and tundra swan males (7.1 kg) and females (6.2 kg). These tundra swan weights are well below the average weights recorded in the present study. Hansen et al. (1971) recorded a mean "bill nail to nostril" measurement of 54.1 mm for 59 adult trumpeter swans on the Copper River, Alaska. Data from adults in the present study indicated mean length of 53.12 mm, 95% C.I. = $\pm$ 2.21, n=20. Banko (1960) stated that swans over one year of age of either sex are probably trumpeters if the "bill nail to nostril" measurement exceeded 50 mm. If this measurement was less than 50 mm, the swan could be considered to be a tundra (Cygnus columbianus). The majority of measurements of NWT trumpeter swans exceeded 50 mm and the mean for females (n=10) was (52.08 mm $\pm$ 1.48). Thus, we believe that all adult birds banded and collared during August, 1986 were trumpeter swans.

5.0 RECOMMENDATIONS

In light of the above discussion and the priorities of the North American Trumpeter Swan Management Plan (Anon. 1984), it is recommended that:

1. further surveys be conducted in the area east of the Liard Valley and south of the Mackenzie River,
2. additional birds be collared to further delineate the migration routes of this population, and

3. surveys be conducted in early summer (June) prior to the development of emergent vegetation, if fixed-wing aircraft are used.

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Appendix 1. Additional observations of trumpeter swans in southern Mackenzie District and vicinity, summer 1986.

Date	UTM Location	Number		Source
		Adults	Cygnets	
spring	WU 750 725	7	-	K. Murray, pers. comm.
summer	VV 665 755	3	-	D. Kirkhus, pers. comm.
28 May	WU 930 715	1	-	Peterson, 1986.
13 June	DC 709 741	2	-	Peterson, 1986.
13 June	DC 599 863	3	-	Peterson, 1986.
13 June	DC 579 853	2	-	Peterson, 1986.
13 June	XV 083 637	2	-	Peterson, 1986.
14 June	XV 222 420	1	-	Peterson, 1986.
28 June	DC 240 913	1	-	Peterson, 1986.
29 June	DC 175 942	1	-	Peterson, 1986.
20 July	DC 583 884	2	-	Peterson, 1986.
20 July	DC 661 820	2	-	Peterson, 1986.
29 July	DB 715 507*	2	-	authors
29 July	EB 337 317*	2	-	authors
30 July	CC 490 650**	2	-	authors
30 July	CC 400 447**	2	-	authors
02 August	DD 300 250	3	-	authors
13 August	XV 428 580	2	-	Peterson, 1986.
17 August	XV 220 624	2	-	Peterson, 1986.

*Northern British Columbia

**Northern Yukon.

Appendix 2. Features of wetlands surveyed in southern Mackenzie District, July 1986

Area No.	Map No.	Wetland[1] Type	Emergent[2] Vegetation	Submergent[3] Vegetation	Edge[4] Width	Turbidity[5] Rating	Habitat[6]
1	95G	1,6	4	1,2	1	1	2
2	95G	1,6	1,4	1	1	1	2
3	95G	1,2,6	4	1	1	1	2
4	95G	2,6	4	1	1	1	3
5	95G	1,2,6	4	1	1	1	3
6	95G	1	4	1	1	1	2
7	95G	1,6	4,3	1	2	1	2
8	95G	2,3,7	4,6	1	1	1	2
9	95G	3,6	3,4,5	1,2	1	1	1
10	95G	1,6	4	1,2	1,2	1	2
11	95G	2,6	2,3,4,5	1,2	1	1	1
12	95G	2,3,5,6	4	1	1	1	1
14	95G	2,3,6	2,4,5	1,2	1,2	1	1
15	95G	1,2	2,4,5	1,2	1	1	2
16	95G	1,2	2,4,5	1,2	1	1	1
17	95G	2,6	2,4,5	2	1	1	2
18	95G	2,6	2,4,5	1,2	1	1	1
19	95G	1	1,2,3,4,5	1,2	0	0	2
20	95B	1,6	1,2,3,4,5	1,2	2	0	1
21	95B	2,3	1,2,3,4,5	1,2	2	0	1
22	95B	2,3	1,2,3,5	1,2	1	1	1
23	95B	3,6,7	1,2	0	1	1	3
24	95B	1,5	4	1	1	1	3
25	95B	1,5	1,2,3,4	1,2	1	1	2
26	95B	1,5	4	1,2	1	1	3
27	95B	1,5	3,4	1,2	1	1	3
28	95B	1	2,3,4,5	1,2	1	1	3
29	95B	1,2,3	2,3,4,5,6	1,2	1,2	1	1
30	95F	1	-	4	1	1	3
31	95C	1,6	2,4	1,2	1	1	3
32	95D	1,2,6	2,4,5	1,2	1,2	1	2
33	95D	2,6	2,4	1,2	1,2	0	2
34	95E	1,6	2,4	1,2	1,2	0	2
35	95E	1,6	2,4	1,2	1	1	3
36	95E	1	-	4	1	1	3
37	95E	1,6	4	2	0,1	0	3
38	95E	1	4	1,2	1	1	3
39	95E	1,6	4	0	0	0	3
40	95E	3,4,6	2,3,4,5	1,2	1	0	2
41	95E	2,3,6	4	1,2	1	1	1
42	95E	1	2,3,4,5	1,2	1	0	1
43	95L	1,5	2,3,4,5	1,2	1	0	1
44	95L	3,6	2,3,4,5	1,2	1,2	1	2

Appendix 2. Continued.

Area No.	Map No.	Wetland[1] Type	Emergent[2] Vegetation	Submergent[3] Vegetation	Edge[4] Width	Turbidity[5] Rating	Habitat[6]
45	95L	1,6	4	1,2	1	0	3
46	95L	1,6	2,4,6	1,2	1,2	0	2
47	105P	6	2,4,6	0	0	0	3
48	105P	1	2,4,6	0	1,2	0	3
49	105P	1	0	0	0	0	3
50	105P	5	4,6	0	0	0	3
51	105P	1,6	2,4,6	2	1	0	3
52	105P	6	2,4,6	0	0	0	3
53	95M	6	2,4,6	2	1	0	3
54	95M	1	4	0	0	0	3
55	95M	1,3,4,6	2,4	1,2	1	1	3
56	95N	1,6	2,4	1,2	1	0	3
57	95N	1,6	2,4,5	1,2	1	1,2	3
58	95N	6	2,3,4,5	1,2	1,2	1	2
59	95N	1,4,5,7	2,4,5	1,2	1,2	1	2
60	95N	1	2,4,5,6	2	1	1	3
61	95N	2,5,6,7	2,4	1,2	1	1	2
62	95N	2,6,7	2,3,4,5,6	1,2	1,2	1	1
63	95K	5,6	1	4	0,1	2	2
64	95K	1,6,7	2,4	1,2	1,2	1	3
65	950	2,6	2,3,4,5,6	1,2	1,2	1	1
66	950	2,3,6	2,4,5,6	1,2	1,2	1	1
67	950	1,3,6	4,5	1	0,1	1	2
68	95K	2,6	2,4,5	1,2	1,2	1	1
69	95K	1,6	2,4	1,2	1,2	1	3
70	95K	1	4	1	1	1	3
71	95K	1	4	0	0	1	3
72	95K	1,6	2,4	1,2	1	1	2
73	95K	1,6,7	2,4	1,2	1	1	2
74	95K	1,6	2,4	1,2	1,2	1	3
75	95K	1,6	2,4,5	1,2	1,2	1	1
76	95J	1,6	2,4	1,2	1,2	1	2
77	95J	6	2,4	1,2	1	1	2
78	105I	1,6	4	1,2	1	0	3
79	105I	1,6	2,4,6	1,2	1,2	0	2
80	105I	6	2,4,6	0	0	0	3
81	105I	1	2,4,6	0	1,2	0	3
82	105I	1	0	0	0	0	3
83	105I	5	4,6	0	0	0	3
84	105I	1,6	2,4,6	2	1	0	3
85	105I	6	2,4,6	0	0	0	3
86	95I	6	2,4,6	2	1	0	3
87	95J	1	4	0	0	0	3

Appendix 2. Continued.

Area No.	Map No.	Wetland[1] Type	Emergent[2] Vegetation	Submergent[3] Vegetation	Edge[4] Width	Turbidity[5] Rating	Habitat[6]
88	95J	1,3,4,6	2,4	1,2	1	1	3
89	95J	1,6	2,4	1,2	1	0	3
90	95J	1,6	2,4,5	1,2	1	1,2	3
91	95J	6	2,3,4,5	1,2	1,2	1	2
92	95J	1,4,5,7	2,4,5	1,2	1,2	1	2
93	95J	1	2,4,5,6	2	1	1	3
94	95J	2,5,6,7	2,4	1,2	1	1	2
95	95J	2,6,7	2,3,4,5,6	1,2	1,2	1	1
96	95J	5,6	1	4	0,1	2	2
97	95J	1,6,7	2,4	1,2	1,2	1	3
98	95J	2,6	2,3,4,5,6	1,2	1,2	1	1
99	95O	2,3,6	2,4,5,6	1,2	1,2	1	1
100	95O	1,3,6	4,5	1	0,1	1	2
101	95O	2,6	2,4,5	1,2	1,2	1	1
102	95J	1,6	2,4	1,2	1,2	1	3
103	95J	1	4	1	1	1	3
104	95B	1	4	0	0	1	3
105	95B	1,6	2,4	1,2	1	1	2

[1] 1=lake, 2=creek, 3=oxbow lake, 4=river, 5=pond, 6=pond complex, 7=muskeg

[2] 0=none, 1=cattail, 2=reedgrass, 3=bulrush, 4=sedge, 5=horsetail, 6=willows

[3] 0=none, 1=lilypads, 2=pondweeds

[4] 0=none, 1=<40 m, 2=>40 m

[5] 0=clear, 1=medium, 2=turbid

[6] 1=good, 2=fair, 3=poor

Appendix 3. Summary of trumpeter swans collared in southern Mackenzie District, August 1986.

Date	Site No.	Map No.	UTM Location	Male		Female	
				Collar No.	Band No.	Collar No.	Band No.
02/08/86	14	95G	DD 620 425	-	-	AA19	519-74456
02/08/86	14	95G	DD 642 500	-	-	AA26	519-74461
02/08/86	14	95G	DD 542 492	AA17	519-74462	AA22	519-74463
02/08/86	15	95G	DD 685 372	AA23	519-74459	AA30	519-74457
02/08/86	15	95G	DD 665 355	AA15	519-74458	AA14	519-74460
02/08/86	15	95G	DD 627 260	AA29	519-74465	-	-
02/08/86	15	95G	DD 627 260	-	-	AA20	519-74465
02/08/86	16	95G	DD 632 230	AA24	519-74466	AA27	519-74467
02/08/86	21	95B	DC 805 537	AA25	519-74468	AA21	519-74469
01/08/86	22	95B	DC 872 470	AA18	519-74452	AA11	519-74451
01/08/86	22	95B	DC 875 515	AA16	519-74454	AA13	519-74453
01/08/86	105	95B	DC 702 390	AA12	519-74455	AA28	519-74470

Appendix 4. Measurements of trumpeter swans captured in southern Mackenzie District, August 1986.

Band No. 519–	Sex	Culmen (mm)	Culmen Width (mm)	Tarsus Total (mm)	Tarsus Bone (mm)	Nares-Bill Tip (mm)	9th Primary (mm)	Weight (kg)
74451	F	122.8	35.0	152.9	125.6	53.6	241	10.2
74452	M	121.4	35.7	153.0	134.0	60.3	185	12.5
74453	F	107.8	35.5	144.0	119.4	51.0	196	11.1
74454	M	118.1	37.1	157.0	138.2	56.9	231	14.3
74455	M	119.9	30.6	156.0	131.4	51.8	245	13.1
74456	F	117.4	34.9	146.0	122.9	53.9	192	10.8
74457	F	118.5	33.7	149.0	125.5	54.5	297	9.5
74458	M	114.5	37.9	159.0	140.5	53.1	333	13.6
74459	M	115.8	35.7	149.0	130.5	56.1	272	11.1
74460	F	117.8	34.3	151.0	119.0	51.5	238	9.8
74461	F	120.1	35.4	152.0	124.0	54.7	162	11.1
74462	M	119.3	36.5	148.0	131.2	56.9	336	12.7
74463	M	109.3	34.9	148.0	125.7	48.4	184	10.2
74464	M	109.9	34.9	142.0	114.6	52.8	181	11.0
74465	F	113.5	34.5	140.0	113.6	52.6	216	9.8
74466	M	107.3	33.8	142.0	121.0	47.4	285	9.3
74467	F	112.0	34.8	144.5	114.7	50.3	286	8.7
74468	M	107.7	36.2	149.0	118.1	54.1	305	10.9
74469	F	113.3	37.1	152.0	125.0	53.1	190	10.4
74470	F	115.0	37.0	150.0	121.9	49.3	279	10.9